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EXPLORATIONS MADE IN COLORADO UNDER THE DIRECTION OF PROF. F. V. HAYDEN IN 1876.

FOR reasons beyond the control of the geologist-in-charge, the various parties composing the United States Geological and Geographical Survey of the Territories did not commence their field work until August. Owing to the evidences of hostility among the northern tribes of Indians, it was deemed most prudent to confine the labors of the survey to the completion of the atlas of Colorado. Therefore the work of the season of 1876 was a continuation of the labors of the three preceding years, westward, finishing the entire mountainous portion of Colorado with a belt fifteen miles in width of Northern New Mexico and a belt twenty-five miles in breadth of Eastern Utah. Six sheets of the physical atlas are now nearly ready to be issued from the press. Each sheet embraces an area of over 11,500 square miles or a total of 70,000 square miles. The maps are constructed on a scale of four miles to one inch with contours of two hundred feet which will form the basis on which will be represented the geology, mineral, grass, and timber lands, and all lands that can be rendered available for agriculture by irrigation. The areas of exploration are located in the interior of the continent, far remote from settlements, and among the hostile bands of Ute Indians that attacked two of the parties the previous year.

The point of departure the past season was Cheyenne, Wyoming Territory. The primary triangulation party was placed in charge of A. D. Wilson, and took the field from Trinidad, the southern terminus of the Denver and Rio Grande Railway, August 18th, making the first station on Fisher's Peak. From this point the party marched up the valley of the Purgatoire, crossed the Sangre de Cristo Range by way of Costilla Pass, followed the west base of the range northward as far as Fort Garland, making a station on Culebra Peak.

About six miles north of Fort Garland is located one of the highest and most rugged mountain peaks in the West, called Blanca Peak, the principal summit of the Sierra Blanca Group. On the morning of August 28th the party, with a pack mule to transport the large theodolite, followed up a long spur which juts out to the south. They found no difficulty in riding to the timber line, which is here about twelve thousand feet above the sea-level. At this point they were compelled to leave the animals, and, distributing the instruments among the different members of the party, proceeded on foot up the loose rocky slope to the first outstanding point, from which a view could be obtained of the main peak of the range. Although this first point is only six hundred feet lower than the main summit, yet the most arduous portion of the task was yet to come. The main summit is about two miles north of the first point, in a straight line, and connected with it by a very sharp-toothed zigzag ridge over which it is most difficult to travel on account of the very loose rocks and the constant danger of being precipitated down, on either side, several hundred feet into the amphitheatre below. After some two hours of this difficult climbing, they came to the base of the main point, which though very steep was soon ascended, and at eleven o'clock, A. M. they found themselves on the very summit. From this point one of the most magnificent views in all Colorado was spread out before them. The greater portion of Colorado and New Mexico was embraced in this field of vision. This point is the highest in the Sierra Blanca group and so far as is known at the present time is the highest in Colorado. The elevation of this point was determined by Mr. Wilson in the following manner: first, by a mean of eight barometric readings taken synchronously with those at Fort Garland, which gave a difference between the two points of 6466 feet; secondly, by fore and back angles of elevation and depression, which gave a difference of 6468 feet. The elevation at the fort was determined by a series of barometric readings, which compared with those of the signal-service barometer at Colorado Springs gave it an elevation of 7997 feet, making the Blanca Peak 14,464 feet above sea-level. This peak may be regarded therefore as the highest or at least next to the highest yet known in the United States. A comparison with some of the first-class peaks in Colorado will show the relative height: —

	Above sea-level.
Blanca Peak	14,464 feet.
Mt. Harvard	14,384 "
Gray's Peak	14,341 "
Mt. Lincoln	14,296 "
Mt. Wilson	14,280 "
Long's Peak	14,271 "
Uncompahgre Peak	14,235 "
Pike's Peak	14,146 "

The foregoing table will afford some conception of the difficulty encountered in determining the highest peak when there are so many that are of nearly the same elevation. About fifty peaks are found within the limits of Colorado that exceed fourteen thousand feet above sea-level.

From this point the party proceeded westward across the San Luis valley and up the Rio Grande to its source, making two primary stations on the way, one near the summit district and the other on the Rio Grande Pyramid. From the head of the Rio Grande the party crossed the continental divide, striking the Animas Park, thence west by trail to Parrott City.

After making a station on La Plata Peak, the party marched northwest across the broken mesa country west of the Dolores, making three stations on the route to complete a small piece of topography that had been omitted the previous year on account of the hostility of the Ute Indians. After making a primary station on the highest point of the Abajo Mountains, the party turned westward to Lone Cone, where another station was made; thence, crossing the Gunnison and Grand rivers, they proceeded to the great volcanic plateau at the head of White River. The final station was made between the White and Yampah rivers in the northwestern corner of Colorado. During this brief season, Mr. Wilson finished about one thousand square miles of topography and made eleven geodetic stations, thus connecting together by a system of primary triangles the whole of Southern and Western Colorado.

In company with the triangulation party, Mr. Holmes made a hurried trip through Colorado, touching also portions of New Mexico and Utah. He was unable to pay much attention to detailed work, but had an excellent opportunity of taking a general view of the two great plain-belts that lie, the one along the eastern, the other along the western base of the Rocky Mountains. For nearly two thousand miles of travel he had constantly in view the Cretaceous and Tertiary formations, with which are involved some of the most interesting geological questions. He observed among other things the great persistency of the various groups of rocks throughout the east, west, and north, and especially in the west, for from Northern New Mexico to Southern Wyoming the various members of the Cretaceous formation lie in almost unbroken belts, while the Tertiaries are hardly less easily followed.

Between the east and the west there is only one great incongruity. Along the eastern base of the mountains the upper Cretaceous rocks, including numbers four and five, are almost wanting, consisting at most of a few hundred feet of shales and laminated sandstones. Along the western base this group becomes a prominent and important topographical as well as geological feature.

In the southwest, where it forms the "mesa verde" and the cap of the Dolores plateau, it comprises upwards of two thousand feet of coal-bearing strata, chiefly sandstone, while in the north it reaches a thickness of 3500 feet and forms the gigantic hogback of the Grand River Valley.

While in the southwest he visited the Sierra Abajo, a small group of mountains which lie in Eastern Utah, and found, as he had previously surmised, that the structure was identical with that of the other four isolated groups that lie in the same region. A mass of trachyte has been forced up through fissures in the sedimentary rocks and now rests chiefly upon the sandstones and shales of the lower Cretaceous. There is a considerable amount of arching of the sedimentary rocks, probably caused by the intrusion of wedge-like sheets of trachyte, while the broken edges of the beds are frequently bent abruptly as if by the upward or lateral pressure of the rising mass. He was able to make many additional observations on the geology of the San Juan region and secured much valuable material for the coloring of the final map.

He states that the northern limit of ancient cliff builders in Colorado and Eastern Utah is hardly above latitude 37° 45′.

The Grand River Division was directed by Henry Gannett, topographer, with Dr. A. C. Peale as geologist. James Stevenson, executive officer of the survey, accompanied this division for the purpose of assisting in the management of the Indians, who last year prevented the completion of the work in this locality by their hostility.

The work assigned this division consisted in part of a small area, containing about one thousand square miles, lying south of the Sierra la Sal. The greater portion of the work of this division lay north of the Grand River, limited on the north by the parallel of 39° 30′ and included between the meridians of 108° and 109° 30′.

This division took the field at Cañon City, Colorado, about the middle of August. The party traveled nearly west, up the Arkansas River, over Marshall's Pass and down the Pomichi and Gunnison rivers to the Uncompahgre (Ute) Indian agency. Here they secured the services of several Indians as escort in the somewhat dangerous country which they were first to survey. This area lying south of the Sierra la Sal was worked without difficulty. It is a broken plateau country and presents many curious pieces of topography. Eleven days were occupied in this work.

The Grand River from the mouth of the Gunnison River to that of the Dolores, that is, for nearly a hundred miles, flows along the southern edge of a broad valley, much of the way being in a low cañon, one hundred to two hundred feet deep. The course of the river is first northwest for twenty-five miles, then turning abruptly it flows southwest, and then south for about seventy-five miles. This valley has an average width of twelve miles. It is limited on the north and west by the Roan or Book Cliffs and their foot-hills, which follow the general course of the river. These cliffs rise from the valley in a succession of steps to a height of about four thousand feet above it, or eight thousand to eighty-five hundred above the sea.

From its crest, this plateau (for the Book Cliffs are but the southern escarpment of a plateau) slopes to the north-northeast at an angle of not more than 5°. It extends from the Wahsatch Mountains on the west, to the foot-hills of the Park Range on the east, and presents everywhere the same characteristics. The Green River crosses it, flowing in a direction exactly the reverse of the dip. It borders the Grand on the north for one hundred and fifty miles, the crest forming the divide between the Grand and the White. On the south side of the crest are broken cliffs; on the north side, the branches of the White River immediately form cañons. This leaves the divide in many places very narrow, in some cases not more than thirty to forty feet wide, with a vertical descent on the south towards the Grand River and an extremely steep earth slope (35° in many cases) at the heads of the streams flowing north to the White River. This crest, though not over eighty-five hundred feet in height, is the highest land for a long distance in every direction.

After leaving the Uncompahgre agency, the party followed Gunnison's Salt Lake road to the Grand and down that river to the mouth of the Dolores, in latitude 38° 50′, longitude 109° 16′. At this point they turned northward and went up to the crest of the Book plateau. They followed this crest to the eastward for upwards of a hundred miles to longitude 108° 15′, then descended to the Grand and followed it up to longitude 107° 35′, and thence went, via the White River (Ute) Indian agency, to Rawlins, where they arrived on October 23d.

The whole area worked is about thirty-five hundred square miles, in surveying which about sixty stations were made. The geological work of this division by Dr. Peale connects directly with that done by him in 1874 and 1875. Sedimentary formations prevail in both districts visited during the past season.

The country first examined lies between the San Miguel and Dolores rivers, extending northward and northwestward from Lone Cone Mountain. The general character of this region is that of a plateau cut by deep gorges or cañons, some of which, especially towards the north, extend from the sandstones of the Dakota Group to the top of the red beds. The depth of the cañons, however, is no indication of their importance as stream beds, for away from the main streams they are dry the greater portion of the year. There are no great disturbances of the strata, what folds do occur, being broad and comparatively gentle.

The San Miguel River, leaving the San Juan Mountains, flows towards the northwest and with its tributaries cuts through the sandstones of the Dakota Group, exposing the variegated beds lying beneath, that have generally been referred to the Jurassic.

About twenty-five or thirty miles north of Lone Cone, the river turns abruptly to the west and flows west and southwest for about fifteen miles, when it again turns and flows generally northwest until it joins the Dolores. Between the San Miguel and Lone Cone the sandstones of the Dakota Group or number one Cretaceous are nearly horizontal, forming a plateau which on approaching the mountains has a capping of Cretaceous shales.

Beyond the bend, the San Miguel flows in a monoclinal valley in which the cañon walls are of the same description as in the upper part of its course. As the mouth is approached the red beds appear. Between this portion of the course of the San Miguel and the almost parallel course of the Dolores, which is in a similar monoclinal rift, there are two anticlinal and two synclinal valleys parallel to each other. They are all occupied by branches of the Dolores. Lower Cretaceous Jurassic and Triassic strata outcrop and present some interesting geological details which will be fully considered in the report on the district. The Dolores River comes from a high plateau in a zigzag course, flowing sometimes with the strike and sometimes with the dip of the strata. Its general course on the western line is about northwest, from which it turns to the northward and westward, finally changing to northwest again for its junction with the Grand. It is in a cañon the greater part of its course.

In the region of country north of Grand River, the geological formations extend uninterruptedly from the red beds exposed on Grand River to the white Tertiary cliffs forming the summit of the "Roan Mountains" or Book Cliffs. The Grand is generally in a cañon in the red beds.

On the north side, the number one Cretaceous sandstone forms a hog-back sloping towards the cliffs. Between the crest of this hog-back and the cliffs, there is a broad valley formed by the erosion of the soft Cretaceous shales which extend to the base of the cliffs and in some places form their lower portion.

The cliffs are composed mainly of Cretaceous beds, rising one above another in steps, until an elevation of about eight thousand feet is reached. The summit is the edge of a plateau sloping to north-northeast. This plateau is cut by the drainage flowing into the White River from the south. These streams rarely cut through the Tertiary series.

Coal of poor quality is found in the sandstones of the Dakota Group and also in the sandstones above the middle Cretaceous beds. Wherever noticed it was in thin seams and of little economic importance.

The White River division was directed by G. B. Chittenden as topographer, accompanied by Dr. F. M. Endlich as geologist. The district assigned to this party as their field for exploration during the season of 1876 commenced from the eastward at longitude 107° 30′, joining on to the work previously done, and extended westward thirty miles into Utah Territory. Its southern boundary was north latitude 39° 30′, while the White River formed the northern limit. In order to complete the work to the greatest possible advantage in the shortest time that could be allowed, it was determined to make the White River agency the headquarters, and in two trips from there finish the work. About thirty-eight thousand square miles comprised the area surveyed.

In working up the topography of the district, the party spent forty-eight days of absolute field work, made forty-one main topographical stations and sixteen auxiliary ones, and traveled within the district about one thousand miles. The party ascertained the course of all the main trails, the location and quality of all the water, which is scanty throughout, and can map with considerable accuracy the topographical forms and all the watercourses. The area is almost entirely devoid of topographical "points" and the topographer is obliged to depend to a considerable degree on those far to the north and south for the triangulation. The country has been heretofore almost entirely unexplored, and was described by the nearest settlers as a broken cañon country, extremely dry. It was marked on the maps as a high undulating plateau, with fresh-water lakes and timber.

The party saw no lakes of more than four hundred yards in diameter and only two or three of those. The country is nearly all inhabitable both winter and summer, and considerable portions of it are valuable, and though three quarters of it is within the Ute Indian Reservation, the advantage of a more accurate knowledge of its character can readily be seen.

While working in the low broken country of Southwestern Colorado last year, Mr. Chittenden made use of a light portable plane table and found it of great value. It appeared at that time that its value was greatest in that class of country, and that in a low rolling district with few prominent points, or in a high-mountain country, it would probably be of little or no use.

Altitudes were determined by the mercurial barometer with a base at the White River Indian agency and checked by a continuous system of vertical angles. The altitude of the agency has been determined by a series of barometric observations extending over two years and a half and referred to railroad levels, and can probably be depended on to within a few feet. The altitude of the agency being about sixty-five hundred feet, and the altitudes in the district ranging from five thousand to eight thousand feet, makes its location the best possible in height for a barometric survey of the region.

It is the intention of the survey during the coming year to publish some tabulated results of the barometric work in Colorado, showing the system and its accuracy and reliability. This may be of use in future work, since the topography of the whole West must greatly depend on barometric determinations of altitude, while Colorado has furnished almost every possible phase of western topography.

The longest dimension of the work lying east and west and the White and Grand rivers running in approximately parallel courses, the district stretched from the White River up over the divide between the Grand and White and embraced the heads of the lateral drainage of the former river.

The general topography is a gentle rise from the White River towards the south, and a sudden breaking off when the divide is reached into rugged and often impassable cliffs known on the maps as the Roan or Book Mountains. The gentle plateau slope of the White River side is cut by almost numberless and often deep cañons, and in many cases the surface of the country has been eroded, leaving broken and picturesque forms, the lower benches generally covered with cedars and piñons, and the upper rich in grass.

There are four main streams draining into the White River within the limits of our work, a distance of something over one hundred miles.

The country is almost entirely destitute of timber and has but little good water. It is, however, abundantly and richly supplied with grass, and, especially in the winter season, must be well stocked with game. It seems well adapted to its present use as an Indian reservation, and is likely to remain for years to come more valuable for them than it could be for settlement.

In the far western portion, and outside the limits of the reservation, one large vein of asphaltum and several small ones were found, and also running springs of the same material, all of which if once reached by railroads will prove of great commercial value. These deposits have been spoken of before, but their location has not been accurately determined. The principal vein seen by this party is at present about one hundred miles from railroad communication, but less than half that distance from white settlements, and is likely in the present rapid growth of the country to be within a few years made available.

According to the report of F. M. Endlich, the geology of the district is very simple, though interesting. Inasmuch as there is but one divide of importance within the district, the work was somewhat simplified. This divide is formed by the Book Cliffs and separates the drainages of the Grand on the south from that of the White on the north. Both of these rivers flow a little south of west into the Green River, which they join in Utah. From the junction of the Grand and Green downward, the river is called the Colorado. Orographically the region surveyed is comparatively simple. The Book Cliffs are the summit of a plateau, about eight thousand feet above sea-level, which continues unbroken over to the Green River. Towards the south these cliffs fall off very steeply, forming deep cañons that contain tributaries of the Grand River. On the north side, with the dip of the strata the slope is more gentle, although in consequence of erosion numerous precipitous cliffs are found. Descending in that direction the character of the country changes. Instead of an unbroken slope, we find that the plateau has been cut parallel by the White River drainage and the long characteristic mesas of that region testify to the action of erosion. Approaching the river, constantly descending with the slight dip of the strata, the bluffs become lower and lower. Though the creek valleys are wide and at certain seasons no doubt well watered, the vegetation is that of an arid country. Dwarf pines, piñons, and sage-brush abound, to the almost entire exclusion of other trees or grass. Traveling down White River this character is again found to change. A new series of bluffs, occasioned by heavy superincumbent strata, gives rise to the formations of deep cañons. For forty-five miles the party followed the cañon of the White, which no doubt is analogous to that of the Green, and probably closely resembles that of the Colorado in its detail features. Vertical walls enclose the narrow river-bottoms and the slopes of the higher portions are ornamented by thousands of curiously eroded rocks. Monuments of all kinds and figures that can be readily compared to those of animated beings enliven the scenery, which otherwise would be very monotonous. Two thousand to three thousand feet may be stated as the height of the walls inclosing the White River. Geologically speaking, the district is one of singular uniformity. Traveling westward, the older formations, reaching back as far as the Triassic, were found. This is followed by Cretaceous, which in turn is covered by Tertiary. About three quarters of the region surveyed was found to contain beds belonging to this period. Owing to the lithographical character of the strata, water was a rare luxury in this region, and men and animals were frequently compelled to look for springs. Farther west still, the Green River Group sets in, forming those numerous cañons of which that of the White River is one.

Having completed their work by October 14th, the party marched eastward through Middle Park, and after twelve days of rain and snow reached Boulder City, Colorado.

The field work of the Yampah division during the past season was principally confined to a district of Northwestern Colorado lying between the Yampah and White rivers, and between Green River and the subordinate range of mountains that lies west of and parallel with the Park Range. The area is embraced between parallels 39° 30′ and 40° 30′ and meridians 107° 30′ and 109° 30′.

The party consisted of Mr. G. R. Bechler, topographer directing, accompanied by Dr. C. A. White, the well-known geologist. They proceeded southward from Rawlins Springs, a station on the Union Pacific Railroad, on August 6th, toward their field of labor. From Rawlins Springs to Snake River, a distance of eighty miles, table-lands form the chief feature of the topography, while from Snake River to the Yampah River the surface is more undulating and thickly covered with sage. Between the Yampah and White rivers, a distance of fifty miles, the country is mountainous; and on the divide between the Yampah and White rivers the elevation is eight thousand to nine thousand feet. Mr. Bechler, after having formed the geodetic connection with the work of previous years, concluded to finish the more mountainous portion of the area assigned to him, which began in the longitude of the White River agency and extended westward to about 108° 10′. Here the party found water and grass in abundance, with one exception.

The plateau country, however, was so destitute of water and so cut up with dry gorges or cañons with scarcely any grass or timber of any kind, that traveling was rendered very difficult. The party therefore made White River its base of supply for water and grass, making side trips among the barren hill-tops or plateaus in every direction.

From the Ute Agency, which is located approximately in latitude 38° 58′ and longitude 107° 48′, the White River takes an almost due west course for fifteen or eighteen miles, most of the way through an open valley with here and there narrow gorges. About fifty miles from the agency, the river opens into a broad barren valley, with only here and there scanty patches of vegetation. Soon after, the river enters a deep cañon with vertical walls one thousand feet or more in height which continue to increase in depth until the river flows into the Green River.

The Yampah or Bear River occasionally deviates from a westerly course only for a few miles. Like White River it flows through a plateau country which rises gently from the river, back for a distance of about eight miles. South of the river lie the Williams River Mountains, which have a gradual slope to the north. Williams Fork, flowing from a southeastern direction, joins the Yampah River. West of the junction, the Yampah traverses the country more or less in a cañon, occasionally emerging into an open grassy valley, then enters a deep cañon, cuts through the Yampah Mountains, when it joins with the Snake River. The place of junction resembles a fine park surrounded on all sides with eroded terraces and plateau spurs, that rise by steps to the divide on either side. This park is about eight miles in length from east to west.

After leaving this park the river enters a huge fissure in the mountains, where it remains until, completing its zigzag course, it joins the Green River in longitude 109° 40′ and latitude 32° 00′.

After the junction with the Yampah, the Green River continues in a cañon for fourteen miles where it passes through the picturesque palisades of Split Mountain into an open broad valley, longitude 109° 15′, latitude 40° 28′, from which point it takes a southeast direction through the Wamsitta Valley, where it unites with the White River.

Into both White and Yampah rivers, numerous branches extend from either side, forming deep cañons the greater portion of their length. We may say in brief, that the sides of the valleys expand and contract, at one time forming the beautiful grassy valleys which in olden times were celebrated as the favorite wintering places for the trappers, or contracting so as to form narrow cañons or gorges with walls of varied height.

The walls of Yampah Cañon average about one thousand feet, while the mountains receding back to the northward attain an elevation of forty-two hundred feet, and the highest point of the plateau on the south side is thirty-four hundred feet above the river level.

Of the plateaus between White and Yampah rivers, Yampah Plateau is the largest, and occupies an area of four hundred square miles. The surface of the summit is undulating and on the south side it presents a steep face, several hundred feet in height, covered with débris, rendering it almost inaccessible. This plateau is covered with excellent grass and gives origin to numerous springs, all of which dry up within a short distance of their source. As a whole, this district is very arid, barren, and almost entirely destitute of tree vegetation.

The total number of stations made by Mr. Bechler in the district assigned to him was forty, and the entire area about three thousand square miles. Barometric observations were made whenever needed, and about two thousand angles of elevation and depression with fore and back sights, so that the material for attaining the correct altitudes is abundant.

The rocks of this district embrace all the sedimentary formations yet recognized by the investigators who have studied the region that lies between the Park Range and the Great Salt Lake, namely, from the Weber Quartzite (which underlies the Carboniferous) to the group or latest Tertiary, inclusive. Not only has the geographical distribution of these formations been mapped, but all the displacements of the strata have been traced and delineated. The last-named investigations bring out some interesting and important facts in relation to the orographic geology of the region, especially as regards the eastern termination of the great Uinta uplift and the blending of its vanishing primary and accessary displacements with those of the north and south range above-mentioned. Much information was also obtained concerning the distribution of the local drift of that region, the extent and geological date of outflows of trap, etc.

The brackish water beds at the base of the Tertiary series, containing the characteristic fossils, were discovered in the valley of the Yampah. They are thus shown to be exactly equivalent with those, now so well known, in the valley of Bitter Creek, Wyoming Territory. These last-named localities were also visited at the close of the season's work, and from the strata of this horizon at Black Butt's Station three new species of *Unio* were obtained, making six clearly distinct species in all, that have been obtained, associated together in one stratum, at that locality. They are all of either distinctively American types or closely related to species now living in American fresh waters. They represent, by their affinities, the following living species: *Unio clavus* Lamarck; *U. securis* Lea; *U. gibbosus* Barnes; *U. metanurus* Rafinesque and *U. complanatus* Solander. They are associated in the same stratum with species of the genera *Corbula*, *Corbicula*, *Neritina*, *Viparus*, etc., this stratum alternating with layers containing *Ostrea* and *Anomia*.

The close affinity of these fossil Unios with species now living in the Mississippi River and its tributaries seems plainly suggestive of the fact that they represent the ancestry of the living ones. An interesting series of facts has also been collected, showing that some of the so-called American types of Unio were introduced in what is now the great Rocky Mountain region, as early as the Jurassic period, and that their differentiation had become great and clearly defined as early as late Cretaceous and early Tertiary times. Other observations suggest the probable lines of geographical distribution, during the late geological periods, of their evolutional descent, by one or more of which they have probably reached the Mississippi River system and culminated in the numerous and diverse forms that now exist there.

The work of the past season shows very clearly the harmonious relations of the various groups of strata over vast areas; that although there may be a thickening or a thinning out of beds at different points they can all be correlated from the Missouri River to the Sierra Nevada Basin. The fact also that there is no physical or palæontological break in these groups over large areas from the Cretaceous to the Middle Tertiary is fully established. The transition from marine to brackish-water forms of life commences at the close of the Cretaceous epoch and without any line of separation that can yet be detected continues on upward until only purely fresh-water forms are to be found. Dr. White, an eminent palæontologist and geologist, says that the line must be drawn somewhere between the Cretaceous and Tertiary epochs, but that it will be strictly arbitrary, as there is no well marked physical break to the summit of the Bridger Group.

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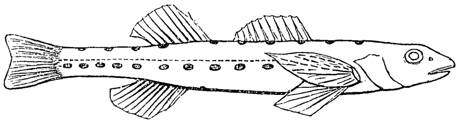
THE SAND DARTER.

BY D. S. JORDAN AND H. E. COPELAND.

WE have often brought home with us a "Johnny," "Speck," or "Crawl-a-bottom," of a different type from any of those whose habits we already knew.[1] It had a very sharp nose that projected over its mouth; its body was exceedingly slim and round, as transparent as jelly, but firm and wiry to the touch. Its belly and much of its back, after a fashion peculiar to itself, were quite bare of scales, and those along the sides were small and inconspicuous. These peculiarities seemed the more striking as the other darters are scaly, and, along the middle line of the belly especially, they are often covered with hard plates, an arrangement obviously adapted to their "crawl-a-bottom" habits.



(FIG. 4.) THE SAND DARTER.

After much searching through the scattered and unsatisfactory descriptions which eastern naturalists have given us of the darters found in their bottles of alcohol, we decided that our little friend was the "pellucid darter," or better, the "sand darter" (*Pleurolepis pellucidus*[2] Agassiz), for reasons soon to be given.

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[1] American Naturalist, June, 1876. Page 335.

[2] As this species is quite imperfectly known to naturalists, we here subjoin its synonymy and a description taken from the average of numerous specimens.

"*Etheostoma pellucidum* Baird MSS., 1853."

Pleurolepis pellucidus Agassiz in Putnam's Bulletin Mus. Comp. Zoöl., 1863, 5. Cope, Cyprinidæ of Penn., Supplement, 1866, 401. Le Vaillant, Recherches sur les Poissons, etc., 1874 Jordan, Indiana Geol. Survey, 1874, 214. Manual Vertebrates, 1876, 221. Jordan and Copeland, Check-List, Bull. Buffalo Soc. Nat. Hist., 1876, 135. Nelson, Bull. Ills. Mus. of Nat. Hist., Dec., 1876, p. 35. Jordan and Gilbert, Fishes of Indiana, Indiana Farmer for Jan. 17, 1877.